Appendix C

Applicable Code Clauses

TECHNICAL SAFETY BC

(Design clauses pulled from the 2001 edition, operational requirements pulled from the 2014 edition). [Currently Adopted].

3.4 General Design Requirements

3.4.1 Design Considerations

3.4.1.1

The design of components for passenger ropeways shall normally include, but shall not be limited to, consideration of the following:

(a) static and dynamic loads;
(b) possible impact loads;
(c) static properties;
(d) fatigue endurance at a number of load cycles appropriate for the component and the installation;
(e) resistance to brittle fracture; and
(f) protection against corrosion.

3.4.1.2

For each item in Clause 3.4.1.1, the design shall be based on the most adverse temperature condition appropriate for the installation.

3.4.2 Design Loads

For the purposes of design, the passenger shall be considered as having a mass of 77 kg.

3.5.3 Quality

The quality and testing of materials, quality of work, and level of inspection of manufactured components shall be appropriate to the level of risk to passenger safety posed by the failure of such components.

3.6 Fatigue Design

3.6.1 General

Components that are subjected to repeated loadings shall be verified against the possibility of fatigue failure. Verification shall be in the form of calculations and/or testing as prescribed by this Standard.

3.6.2 Critical Components

3.6.2.1

Critical components and their connections shall be designed to resist the effects of fatigue. Design calculations shall be based on generally accepted procedures.

3.6.2.2

Critical components and their connections shall be designed, detailed, and fabricated so as to minimize stress concentrations.

3.6.2.3

The minimum number of cycles used for design and/or testing purposes shall be based on a design life expectancy of 30 years, unless otherwise stated. Consideration shall be given to the type of equipment and the conditions under which it is expected to operate.

3.27 Carriers

3.27.1 Static Strength

Carriers shall be designed for the following forces:
(a) dead weight of all parts including all accessories;
(b) live load;
(c) forces acting on rope grip components to develop the necessary resistance to sliding;
(d) forces exerted by the evacuation device on the point of suspension (to be not less than 2.5 kN); and
(e) centrifugal forces due to travel around the return sheaves.

3.27.2 Factors of Safety

3.27.2.1

The factor of safety with respect to the yield strength for forces in Clause 3.27.1, Items (a), (b), and (c) acting together, shall be not less than 3.0.

3.27.3 Endurance

3.27.3.1

Components of carriers for above-surface circulating passenger ropeways shall be designed to withstand an endurance test, of 5×10^6 cycles, consistent with dynamic loads applied during operation, and with the design gripping force present.
Note: *The test may be performed on separate component parts or subassemblies.*

3.27.3.2

Where operating load data is unavailable, the test shall be performed with parameters generating variation of dynamic forces at the grip level not less than twice the weight of a loaded carrier.

3.27.4 Material

The materials used in the manufacture of passenger carriers shall be of suitable quality, the certificates for which shall be made available.

Due attention shall be given to proper selection of material, shape, and surface quality of parts with respect to endurance and resistance to brittle fracture within the range of operating temperatures. In particular, the following properties shall be specified for the material of every component part (wherever applicable):
(a) static strength, yield point, and ductility at operating temperatures;
(b) condition (heat treatment, etc);
(c) notch toughness, transition temperature;
(d) weldability, suitability for drop-forging, etc;
(e) corrosion resistance, resistance to corrosion embrittlement;
(f) surface quality and/or treatment;
(g) basic fatigue limit (endurance);
(h) notch sensitivity; and
(i) stability of mechanical properties with time (aluminum alloys).

3.27.5 Manufacturer's Tests

3.27.5.1

The haul rope grip, connection, and critical parts of the carrier for above-surface ropeways shall, at the time of manufacture, be nondestructively tested using a method commensurate with the design and materials to ensure that they are free from flaws and cracks. Certificates to this effect shall be provided by the manufacturer stating the serial numbers of the items tested, the tests carried out, the conclusions of the tests, and the installation on which the components are to be used.

3.27.7 Identification

Each carrier hanger for above-surface ropeways shall be marked permanently with a serial number at the time of manufacture.

****Clauses below from the 2014 edition of the CSA Z98 Code****

12.4 Operational inspection

12.4.1 Daily inspection

A daily inspection shall be conducted before passengers are transported. At a minimum, the inspection shall consist of the following:

a) a visual inspection of each terminal and station and of the entire length of the ropeway or conveyor;
b) an inspection to check that the tensioning carriage, counterweights, or other tensioning devices are functional and have adequate travel, with clearance at both ends of travel;
c) operation of manual and automatic switches in stations and loading and unloading areas;
d) operation of braking systems (with the exception of track rope brakes, which shall be tested at least once a year);
e) operation of communication systems;
f) operation of the ropeway or conveyor, including a visual inspection of all ropes and carriers and of the complete length of the belt;
g) an inspection to check that loading and unloading areas are clear of obstructions and correct clearances are maintained;
h) an inspection to check that required clearance to snow and obstructions exists below carriers;
i) an inspection to check that signs are in place and clearly visible; and
j) an inspection of attachments for secondary carriers.

12.4.5 Recording of and action on abnormalities

All abnormalities discovered during the daily inspection shall be recorded in the logbook and the appropriate action taken.

12.8.3 Critical component failure

12.8.3.1
If a critical component is found to have failed, it shall be immediately removed from service, provided that such removal does not create a further hazard.

12.8.3.2
If a failed critical component cannot be removed from service, the ropeway or conveyor shall be evacuated and operation shall be discontinued.

12.8.3.3
The failure of the component shall be investigated by a qualified person to determine the cause. At a minimum, the investigation shall consider

a) design;
b) material;
c) processing and manufacturing;
d) assembly;
e) service conditions;
f) maintenance; and
g) operation.

12.8.3.4
If the cause of failure cannot be established as being unique to the individual failed component, all similar components shall be subjected to a non-destructive examination or replaced before operation is resumed. Clause 12.18 shall be applied to the fullest extent possible.

12.8.3.5
If the investigation and subsequent inspection reveal that the deficiency is not an isolated incident, the manufacturer shall be notified.

12.9 General inspection and maintenance
Foundations and all structural, mechanical, and electrical components shall be inspected annually and maintained in a state of good repair.

12.18 Non-destructive tests of carriers on above-surface ropeways

12.18.1 General

12.18.1.1
Carriers shall be tested and/or inspected in accordance with criteria established by the manufacturer.

12.18.1.2
The test and/or inspection method shall take the following into account:
a) the type of material;
b) the test location; and
c) the type of flaw for which the test is being conducted.

12.18.1.3
The test and/or inspection shall be carried out by qualified persons.

12.18.1.4
The test and/or inspection and any subsequent repairs shall be documented and the records shall be kept.

12.18.2.1
As a result of a visual inspection, any suspected defect discovered shall be non-destructively tested as specified in Clause 12.18.

12.18.2.2
When a defect or flaw is discovered, the designer, the manufacturer, or an engineer shall
a) provide the details of any modification, repair, or replacement required;
b) determine the frequency, method, and details of any further action required to show that other similar components are satisfactory for further use; and
c) verify that the repair, modification, or replacement has corrected the problem.

12.18.3 Tests and inspections for circulating passenger ropeways

12.18.3.1
The tests and inspections specified in Clause 12.18.3.2 shall be conducted at intervals established by the designer, manufacturer, or engineer based on experience of the performance of the components.

12.18.3.2
Tests and inspections shall be conducted as follows:
a) All grips or inserts and hanger connections shall be disassembled, cleaned, and visually inspected in accordance with the manufacturer's requirements.
b) All grips or inserts, hangers, and carriers shall be visually inspected at least once every 500 h of operation.
c) At yearly intervals, a minimum of 20%, or a total of ten, whichever is greater, of grips or inserts, hangers, and critical carrier locations shall be non-destructively tested on a rotational basis, such that none of these components shall be in service for more than five years without being tested.

Note: *A sample of a grip carrier non-destructive test report is included as Annex F.*

13.7 Hazardous conditions

13.7.1 Wind or icing

13.7.1.1
The operator shall be kept advised of adverse changes in weather conditions.

13.7.1.2
When wind or icing conditions are such that continued operation could become hazardous to passengers or equipment, the ropeway shall be unloaded and operation discontinued.

13.16 Manual evacuation

13.16.1 Evacuation plan
For above-surface ropeways, a written plan for evacuating passengers in a reasonable length of time shall be provided (see Clause 13.4.3). The plan shall include

a) the definition of the line of authority in the event of an evacuation, including the
   i) person(s) responsible for ordering an evacuation;
   ii) person(s) responsible for performing the evacuation, first aid, and ground care of evacuated passengers; and
   iii) minimum number of trained personnel required during operating hours for each task related to the evacuation procedure identified in the evacuation plan;
b) a description of the equipment necessary for evacuation and where it is stored;
c) an estimate of the time necessary for complete evacuation of the ropeway;
d) a description of unusual terrain conditions and how each condition shall be dealt with during an evacuation;
e) an estimate of when an evacuation should begin in the event that the ropeway becomes inoperable;
f) provision for communication with passengers of an inoperable ropeway, including
   i) when communication shall start; and
   ii) how often subsequent communication shall be repeated;
g) the method of evacuation to be used for a typical passenger and the method to be used for an incapacitated passenger;

h) provision for communication with the evacuation teams;
i) provision for control and assistance of evacuated persons until released;
j) provision for suspending the evacuation if the ropeway is made operable during the evacuation; and
k) provision for a post-evacuation report.

13.16.2 Personnel and equipment

13.16.2.1
During all operations, the equipment and trained personnel required by Clause 13.16.1 shall be available.

13.16.2.2

Devices shall be capable of lowering passengers to the ground or rescuing passengers from the locations at which the devices are to be used.

13.16.2.3

The following shall be taken into account to determine the equipment required:

a) probable operating and evacuation conditions;
b) storage locations;
c) number of ropeways at a specific location; and
d) periods of operation that can influence evacuation (day, night, or dusk).

Annex F (informative)
Grip carrier non-destructive test report

Note: *This Annex is not a mandatory part of this Standard.*

Company reg. #			Company name:		
Ropeway reg. #			Ropeway name:		
Ropeway manufacturer:			Report date: Y M D		
Date grip installed	Y M D		Date carrier installed	Y M D	
Grip test date			Carrier test date		
Test method grip			Test method carrier		
Number of grips tested			Number of carriers tested		
Number of carriers on line			Number of carriers designed		
Number of grips rejected			Number of carriers rejected		
Number of grips repaired			Number of carriers repaired		
Number of grips replaced			Number of carriers replaced		
Next test date grips	Y M D		Next test date carriers	Y M D	
Tester's name			Tester's signature		

Details of tests (refer to attached sketches for flaw locations)
Identify sketch number and flaw area section

Grip #	Flaw location	Description	Carrier #	Flaw location	Description